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Role of Vegetation in the Microclimatic Conditions: Formulation of Urban Heat Islands

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Abstract: ***Cities, or urban areas face many challenges, be it the pressure on infrastructure or continuous sprawl, but the worst of the challenges are the impacts of global warming on cities. Urban areas, due to scarcity of mitigation efforts, face the most significant climate change. One such impact is the formation of urban heat islands within the cities. Not only are there urban heat islands within the microclimate of a city, but also city as an entity, in general becomes a heat island when seen in cohesion with the adjoining peri-urban and rural areas. The cause of this phenomenon itself is the way to mitigate it. The surface of an urban area and a rural area are significantly different, where rural areas have more of vegetation and water bodies, which serves as heat sinks, urban areas in contrast, lack these surfaces to an extent that within the same city boundary one can witness a varied range of temperature differences. Even the increasing pollution in cities, adds to the UHI effect. The automobile driven societies, are laying down roads every day, but not sensitive to the fact the vegetation along the roads is an important feature of the network itself. During summers, we immediately feel the heat on the roads and witness the mirage effect. So on some levels, within a neighbourhood, with buildings, parks, and roads, roads by default would have a higher temperature due to the vehicles, and surface quality of the road. This paper would first identify the difference in the surfaces in rural, peri-urban, and urban areas with respect to their impacts on the environment. With the help of suitable examples this difference would be established in connection to formation of urban heat islands. Also case studies of how this urban heat island has been mitigated in cities and what role has vegetation, water bodies and urban open spaces have played in the same.***

1. Introduction

Vegetation, in the urban areas, holds a significant importance in terms of having significant impacts on the microclimatic conditions of any region. Due to the fast pace of urbanization, this very vegetation cover is being altered every day, it becomes important to study the impact that vegetation have on the microclimatic conditions and the probable effects it can have in mitigation strategies to maintain the thermal comfort and the reduction in the urban heat island effect. Shaded surfaces, for example, may be 20–45°F (11–25°C) cooler than the peak temperatures of unshaded materials.

1.1 Urban heat island effect

With the increase in population, we can expect an increase in demand for housing, thus there would be a need to build more housing for the people. As such building on every piece of land that can be found in a city becomes inevitable.Large areas of vegetation will have to be destroyed in order to develop more new towns. Naturally vegetated surfaces will be replaced by buildings and paved streets. But most importantly, the additions of vegetation are usually lagging behind the town development. As a consequence of replacing vegetation with dark coloured surfaces, city temperature is now higher than ever before. This unusual phenomenon is referred to as the “urban heat island effect”. The lack of vegetation and the use of dark coloured surfaces such as asphalt are two of the largest contributors to urban heat.

2. UHI in world

Citywide temperatures are affected by the individual contributions of all the buildings and vegetation on it. Studies had shown that vegetation had significantly reduced the temperatures in city areas. The reduction in the green area densities will have an adverse effect on air temperature. The same was studied for many cities like Los Angele and Singapore etc. over the period 1882-1984 in Los Angeles, With increasing irrigation and orchards, the city cooled by 2K until the 1930s. Since then, as asphalt replaced trees, the city was warmed by 3K. Similarly it was found that temperatures in San Francisco’s Golden Gate Park, which contains high levels of vegetation, average about 8K cooler than nearby areas that have much lesser vegetation.(L. Shashua-Bar a, 2000)

All these led to an understanding that decreasing vegetation would have an adverse effect on the microclimate of the area. Also it was realized that with large scale plantation interventions these adverse affects could be reversed as well. Studies had been done by researchers, which try to simulate the effect of additional vegetation on the temperatures and had provided useful information. Computer simulations predict that increasing the tree cover by 25% in Sacramento and Phoenix, USA would decrease air temperatures by 6 to 10.0 deg F.

2.1 UHI in Indian context

Studies have been conducted to find out the UHI effect in Indian cities. A study on finding out whether change in various land cover in Pune contributes to the change in land surface temperature over a period from 1999 to 2006 was done and as an outcome it was found that the built up area was increased 32.68% which lead to a sharp decline of 10% area in agriculture, 21.91% area in barren land in mostly attributing to intense urbanization process and Vegetation had been decreased by 10%. As a result, there had been a 1˚C to 4˚C rise in surface temperature in Pune since 1999 to 2006.

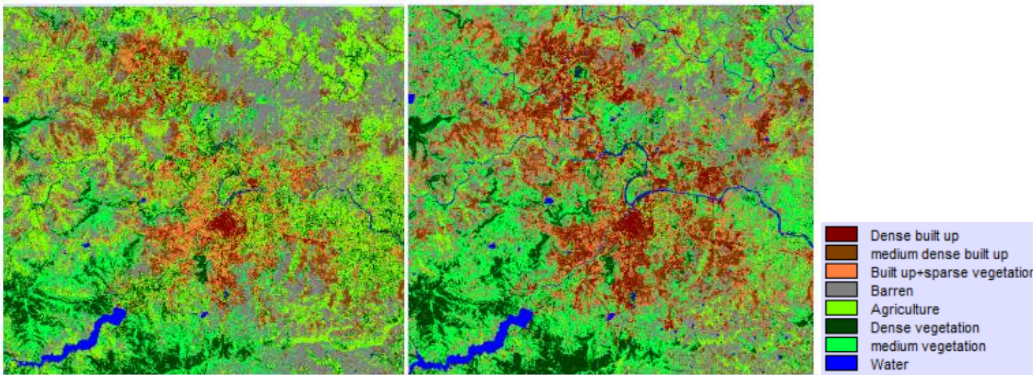

Figure 1: Pune Land cover (a) 1999, (b) 2006

Similarly in Bangalore, during a study it was found that the rapid development of urban sprawl has many potentially detrimental effects including the loss of valuable agricultural and eco-sensitive (e.g. wetlands, forests) lands, enhanced energy consumption and greenhouse gas emissions from increasing private vehicle use. Vegetation has decreased by 32% from 1973 to 1992, by 38% from 1992 to 2002 and by 63% from 2002 to 2009. Disappearance of water bodies or sharp decline in the number of waterbodies in Bangalore is mainly due to intense urbanisation and urban sprawl. Many lakes (54%) were unauthorised encroached for illegal buildings. Field survey shows that nearly 66% of lakes are sewage fed, 14% surrounded by slums and 72% showed loss of catchment area. It is clear that urban areas that include commercial, industrial and residential land exhibited the highest temperature followed by open ground. The lowest temperature was observed in water bodies across all years and vegetation. (T.V., 2010)

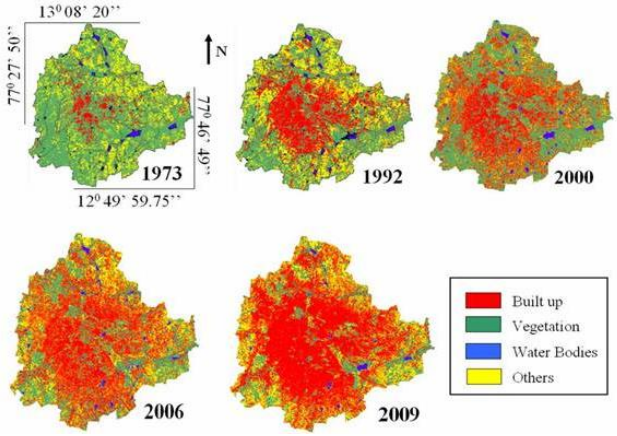

Figure 2: Land cover Bangalore

In case of Delhi, it is observed that temperature has risen 2 degree C to 3 degree C in just 15 years. This has happened due to decreasing vegetation in the urban areas and the increase percentage of barren lands in the peripheral areas of the city. There is a constant reduction in the heat sinks which results in formation of urban hotspots or urban heat islands.

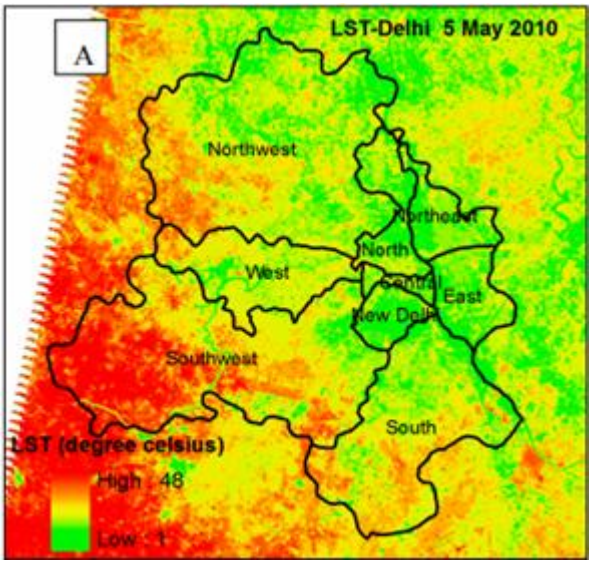

Figure 3: Land surface temperature of Delhi

Similar results were observed in other Indian cities of various class size. There was found a direct interrelationship between urban vegetation area which acts as a heat sink and the urban land surface temperatures.

Even on a smaller scale, like a neighbourhood, the effect of vegetation on the microclimatic condition of the area can be observed to have lower temperatures when compared to surrounding areas. In the fig below one can see the difference in temperature around the area with buit-up mass and the area with vegetation.

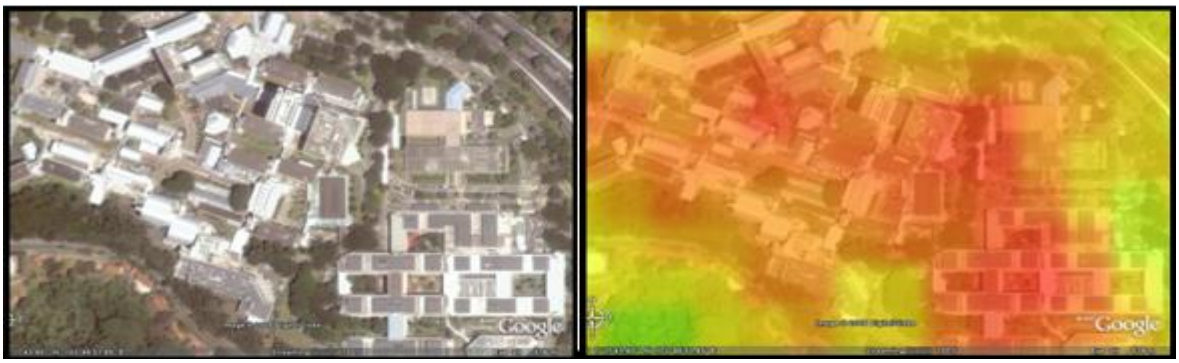

Figure 4: Lower temperature in area with more vegetation

3. Conclusion

Along with all the benefits of vegetation one of the most important and desperately required benefit of vegetation is the decrease in temperature due to vegetation. Cities are facing the problem of varied microclimatic conditions within the city limits which have an adverse effect in the ecosystem and the overall health of the city. Thus Mitigation of UHI becomes an agenda which should be given priority in Indian cities. Increase in plantation would reduce the temperatures and improve the microclimatic conditions of any area, thereby reducing the risks involved with excessive heat like heat strokes.

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